# User Manual

# ALL-TEST *PRO*® 33 INDUSTRIAL

## For Firmware IND130516A4 & IND130516B4 or higher

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# CONTACT INFORMATION

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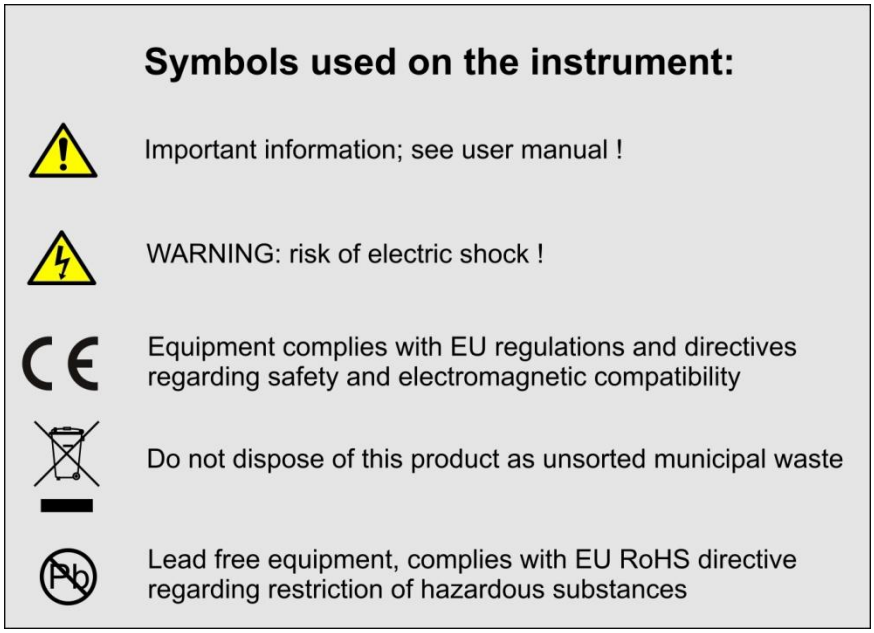
Symbols used on the instrument:
Important information; see user manual !
WARNING: risk of electric shock !
Equipment complies with EU regulations and directives regarding safety and electromagnetic compatibility
Do not dispose of this product as unsorted municipal waste
Lead free equipment, complies with EU RoHS directive regarding restriction of hazardous substances

***NOTE: Color illustrations and images are used in this manual and we recommend printing it using a color printer, if a hardcopy is desired.***

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# INTRODUCTION to the ALL-TEST PRO® 33

## Test Instrument / Analyzer / Data Collector for Electrical Motors

Congratulations on your purchase of the new patented **ALL-TEST *PRO*® 33** Motor Circuit Analyzer (AT33) from **ALL-TEST *Pro*, LLC (ATP)**. The ATP AT33 is the first in a new series of hand-held Motor Test Instruments and is available in the Industrial (IND) or in the Electric Vehicle (EV) version. The IND version is optimized to test AC induction motors with squirrel-cage rotors that operate up to 1000VAC (if your testing application includes motor operating voltages that exceed 1000V contact us at info@alltestpro.com for testing options). The EV version is for testing Permanent Magnet (PM) type motors and motor/generators used in hybrid and electric vehicles. Additionally, the EV version has application with testing other types of PM motors. Contact info@alltestpro.com for further information.

The 33 series forms the base in a complete system solution for stand-alone trouble shooting/ fault localization; quality control of stored or incoming new/repaired motors; as well as data collection and trending for early fault detection when combined with the optional PC software.

The ALL-TEST *PRO* 33 performs Motor Circuit Analysis (MCA) as a series of low voltage tests to identify faults inside an electric motor. The AT33 detects winding contamination, stator faults such as turn-to-turn and coil-to-coil, open connections, ground faults, and broken/fractured rotor bars. Experience has proven that the ALL-TEST *PRO* series of Motor Test Instruments are the most powerful and easiest to use diagnostic tools available for de-energized testing of motors in today's industry.

The AT33 is designed to be used as a stand-alone unit in the field or workshop, or with optional Windows based software for further analysis, reporting, trending and database. Has a built-in real time clock and large memory for storage of test and reference data. The instruments are built to exacting standards and rugged to handle the daily use in tough industrial environments. The rechargeable Lithium batteries support eight hours or more of testing and data collection*.

* Assumes most testing is phase to phase. Performing insulation to ground testing in applications where there are long cable runs will increase the drain on the battery. Therefore, user may not get 8 hours of use between battery charges.

## SAFETY WARNINGS

**Safety Warnings and Precautions must be read and understood before the instrument is used. They must be observed during use.**

**Follow all safety rules of your company and OSHA (or country equivalent) for off-line testing methods, including the wearing of appropriate Personal Protective Equipment (PPE).** ***Improper or unsafe operation of the ALL-TEST PRO® 33 is the sole responsibility of the user.***

**The ALL-TEST *PRO*® 33 is only to be used on de-energized motors. Connecting the instrument to live voltage will destroy the unit and void the warranty. Always verify the motor circuit is de-energized before connecting the AT33.**

**Ensure that all power has been removed from the circuit being tested, including static power stored in capacitors. Discharge all capacitors being tested. During testing, ensure that one leg of any power factor correction capacitor or lightning arrestor that is in the test circuit are disconnected to avoid erroneous test results.**

**For MCA testing, the ALL-TEST PRO® 33 sends out a low voltage, high frequency test signal not harmful to the technician or most electronic equipment (variable frequency drives and soft starters). However, electronic equipment and personnel must observe appropriate safety considerations (disconnect electronic equipment) when performing the insulation to Ground Resistance Test (Meg-Ohm test).**

**Test leads, including crocodile clips, must be in good order, clean and have no broken or cracked insulation.**

## INSTRUMENT WARNINGS

**Do not open the main body of the instrument. Electrostatic charges may damage surface mount electronics. Additional battery packs can be purchased from ALL-TEST Pro, but care must be exercised during battery installation, as electrostatic charges may damage surface mount electronics. Contact your distributor of the AT33 or ALL-TEST Pro (+1 860.399.4222 or email info@alltestpro.com) to purchase a battery pack and for battery installation instructions. NOTE: Only approved original equipment (OEM) battery pack should used and use of non-OEM types will void your warranty!**

**Use only the supplied charger for charging the instrument. It is an integral part of the charging circuit. Using the wrong charger could damage your instrument and void the warranty.**

## ALL-TEST *PRO* 33 KIT

**STANDARD EQUIPMENT**

- ALL-TEST *PRO* 33 with back-lit graphic LCD screen (128x64 pixel)
- 3x Test leads with custom Kelvin Clips
- 1x Test lead with 4mm safety plug and "Dolphin" clip
- Battery charging adapter
- Attaché type hard case with pre-cut foam liner
- User Manual on CD

**AVAILABLE ACCESSORIES**

- Windows (XP/7) based software for database storage, further analysis, reporting and trending
- USB cable 1m (for PC communication)
- Soft carrying pouch for instrument and test leads
- Battery pack and DC charger

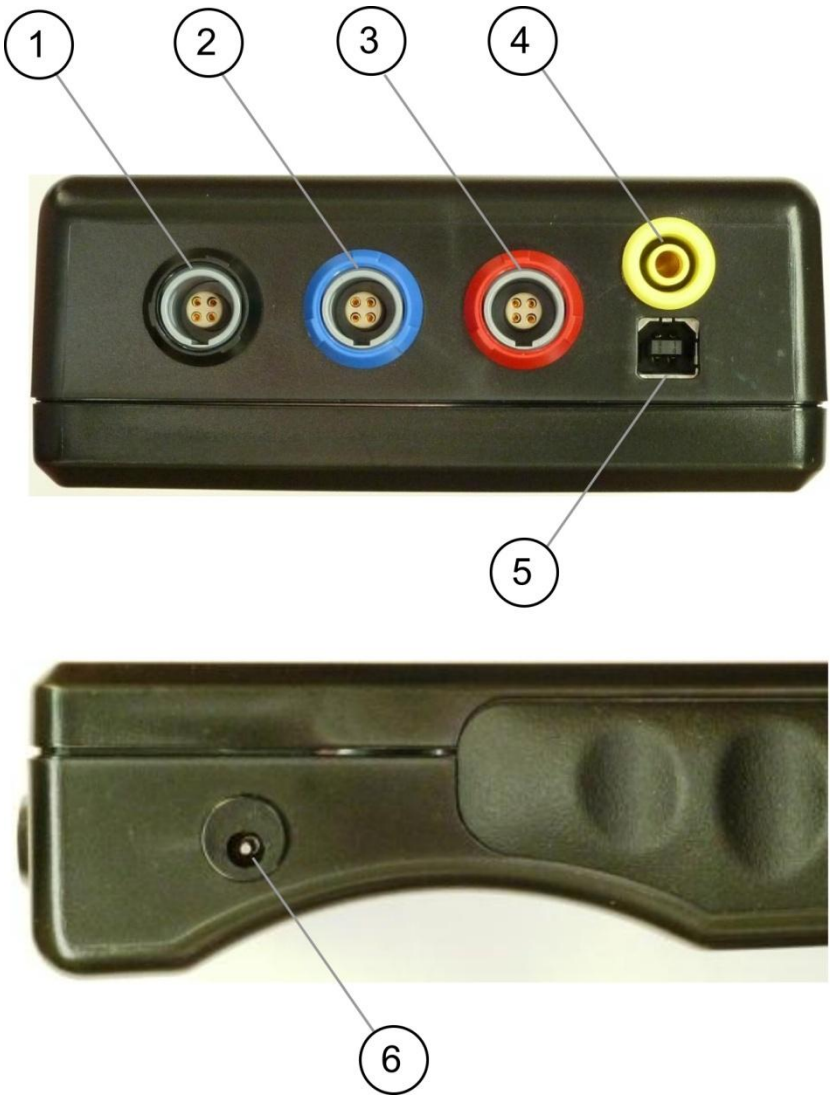
**TRAINING**

Continuing Education Accredited Training Courses are held at various locations throughout the world. In addition, all of the ALL-TEST *Pro* training courses can be customized and brought to your plant site. Contact ALL-TEST *Pro* training department at www.alltestpro.com for further information.

**WARRANTY**

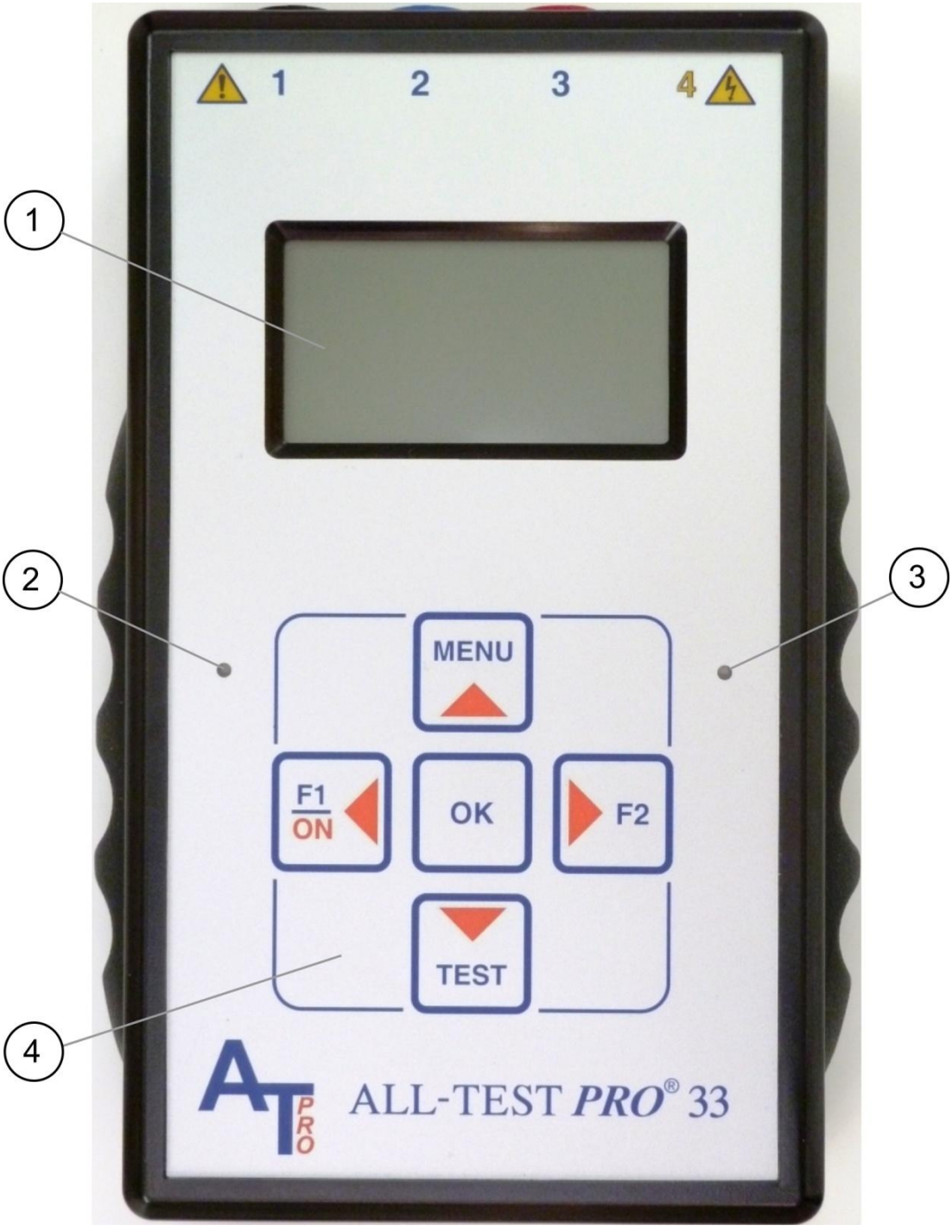
One year limited warranty. See ALL-TEST *Pro* Terms and Conditions for details.

# INSTRUMENT CONNECTIONS LAYOUT




1. Phase 1 Test Lead input/output port **BLACK**
2. Phase 2 Test Lead input/output port **BLUE**
3. Phase 3 Test Lead input/output port **RED**
4. 500V & 1000V / Dissipation Factor / Capacitance output test port **Yellow**
   WARNING: Risk of electric shock!
5. USB port (type B) for PC communication
6. Charger input DC 9V, 1.7A (center pin + polarity) CAUTION: Only use the supplied charger for charging. Using the wrong charger could damage your instrument and void the warranty. Keep instrument plugged into charger when not in use.

# FRONT PANEL LAYOUT




1. Graphical LCD display 128x64, white LED backlight
2. Charging status indicator LED, bicolor **Red** / **Green**
3. Active status indicator LED **ORANGE**
4. Keypad area, sealed tactile switches

## BATTERIES AND CHARGING

The built-in rechargeable Lithium (Li-ION) batteries support eight hours or more of normal testing.
2.5 hours is typically necessary to fully charge the battery. Do not charge when ambient temperature is below or above range as listed in the specification document. Charge the battery if the Tester is not used for extended periods.

⚠ CAUTION: Only use the supplied charger for charging. Using the wrong charger can damage your instrument.

**Charging status is indicated by bicolor LED to the left of keyboard:**
**Red** = Battery conditioning and charging, **Green** = Charge complete (Done)
**Red + Green** = Sleep mode or temperature fault, **OFF** = Charger not connected

Battery voltage is independently monitored and indicated in the main menu, as one of four possible levels or will show the word “LOW”.

When the charger is plugged into line power the charging circuit automatically resumes charging when the battery voltage falls below the preset threshold.

**Note:** The Li-ION batteries have built in over-discharge protection circuits, activated if the cell voltage falls below a threshold that will disconnect the cell resulting in no power! The solution is to recharge the batteries.

## BASIC INSTRUMENT OPERATION

**Turning the instrument ON:**
Press the "ON" key for a few seconds until the display lights up and shows the main menu.
***Instrument will power off after approximately five minutes of inactivity.***

**Note:** If the instrument does not turn on, the most likely cause would be that the Li-ION batteries built-in over discharge protection circuits have switched off, resulting in no power. The solution is to connect the charger to the instrument in order to recharge the batteries.

**Turning the instrument OFF:**
Select the "PWR OFF" icon in the main menu with the arrow keys and then press "OK" key.

**How to RESET the instrument:**
Simultaneously press the left and right arrow keys for a few seconds and then release.
This will perform a forced hardware & firmware reset and will return the display back to the main menu.

# MAIN MENU

The MAIN MENU presents the user with the following main selection icons and information:

- **"IND"** icon selects Testing Industrial AC Motors using all available instrument features.
- **"DYN"** icon selects "Dynamic only" motor testing.
- **"INS"** icon selects "Insulation Resistance only" testing.
- **"SET"** icon selects various set and support functions.
- **"PWR OFF"** icon selects power off.
- Battery voltage status indicator shows one of four levels or "LOW".
- Real Time Clock Date and Time information.

# AC MOTOR TESTING - STATIC & DYNAMIC

The new Patented & Patent Pending analysis methods and measuring technologies are divided into two main testing types: **"STATIC"** and **"DYNAMIC".**

The term **"STATIC"** refers to the testing methods possible when the rotor shaft is not accessible for rotation. I.e. rotor shaft position is fixed.

The term **"DYNAMIC"** refers to all testing methods possible when the rotor shaft is accessible for manual rotation, whether by hand or other aid, during testing.

After completing a test "path" the AT33 will automatically "ANALYZE" the test result of each parameter and presents the result in a user friendly format. Analysis results include one of three possible levels: **"OK"**, **"WARN"** or **"BAD"** based on the preset rules. In case only "STATIC" testing was possible the user has the option to compare the new results with already preloaded or saved record in the memory, or to save the current test as a baseline reference test.

Saved test records can be uploaded to the optional PC software for further analysis, trending, data base management and report generation.

## "STATIC" – tests and measuring functions

**"Test Value Static / Reference Value Static" (patented):** Makes measurements on all three phases and calculates a "Test Value Static", which when compared to a baseline "Reference Value Static", becomes a powerful combined fault indicator for Rotor and Stator faults. The "Reference Value Static" is normally saved from the first time the motor is tested (a baseline test) or can be saved from a known good motor when you have many of the exact same motor type.

**Contamination:** Measures the Dissipation Factor (DF) and the capacitance between motor frame – stator windings.

**Resistance:** 0-999Ω, resolution 0.01mΩ. True 4-wire Kelvin measurement for accurate low resistance results (includes automatic compensation for thermoelectric offset voltages).

**Insulation Resistance:** 0 – 999MΩ @1000V, 0 – 500MΩ @500V

**Static tests (*except for DF and Capacitance*) can be performed directly at the motor or from the starter or motor drive. However, testing from the starter or motor drive can introduce external sources of interference that can influence the test results. User should repeat any test from the starter/drive to verify measurements are repeatable.**

## "DYNAMIC" – tests and measuring functions

**"Test Signature" (patented):** Measures, in real time during manual rotation, a number of parameters in all three phases which together forms the "Test Signature" for the rotor and stator. The "Test Signature" is then automatically analyzed in the AT33 and gives the user immediate results for Stator and Rotor status. The "Test Signature" can also be uploaded to the optional PC software and evaluated further by a trained technician.

**Dynamic tests are best performed directly at the motor. Testing from the starter or motor drive can introduce external sources of interference that can adversely influence the test results.**

## RECOMMENDED TESTING PROCEDURES

1) Prior to installing the motor a DF/C + Insulation + Static + Dynamic test should be performed directly at the motor leads and then saved as a reference test.
2) After the motor is installed then an Insulation + Static test should be performed from the starter/drive and then saved as another reference test. This test should be repeated to verify stable results are achieved. If erratic results are seen then consult Addendum A for guidelines.
3) Subsequent Insulation + Static testing can be done whether for trouble-shooting or other purposes. If a change in either the Insulation or Static test is observed then both tests should be performed at the motor with incoming leads removed from the motor.
4) This new Insulation + Static test at the motor terminals should now be compared to the initial reference static test that is mentioned in item 1.
    a. If the values have not changed from the initial static test then likely the problem is related to cables/connections between starter/drive and motor.
    b. If values have changed from initial static test then the user will need to perform a complete DF/C + Insulation + Static + Dynamic to determine the root cause for this change.

# STATIC TESTS

# 1. CONTAMINATION TEST (DF and CAPACITANCE)

The Dissipation Factor test (DF) & Capacitance test (C) of the AT33 is a low voltage method to measure the Dissipation Factor [also known as tan delta (loss angle)] and the Capacitive system inside the motor formed by the motor frame and the stator windings. Due to the inherently high impedance nature of the DF & C test the AT33 connection is designed to form a shielded test setup together with the motor object under test.
<u>All DF & Capacitance testing should be performed directly on the motor terminals as instructed and pictured in this Manual.</u>

Only the supplied (shielded) test leads and clips should be used. The use of any additional cable(s) between the test clips and motor terminals can introduce hum and/or other interference that can result in erratic readings for DF and C. In addition, longer cable lengths can also add the influence of the cable itself.

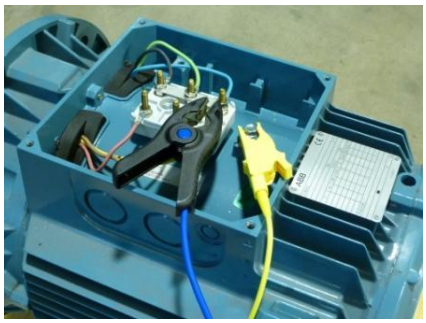
In order to get the highest possible accuracy for the DF test, the instrument should be allowed to have a warm up time of approximately 10 seconds after powering “ON” (this allows time for the DC and offset levels to stabilize). Note that the specification for DF and Capacitance is based

on battery powered operation. The USB communication cable cannot be connected to a computer during the Contamination test described below.

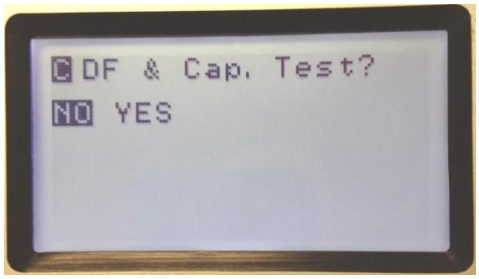
**To start motor testing:** Select the "IND" icon in Main Menu and press OK key.

Now connect the Test Leads according to instructions in the message screen:
"Connect BLUE clip to Phase 2 and YELLOW to Frame, OK to continue…."

This connection will prepare the instrument for the DF, Capacitance and Insulation tests.



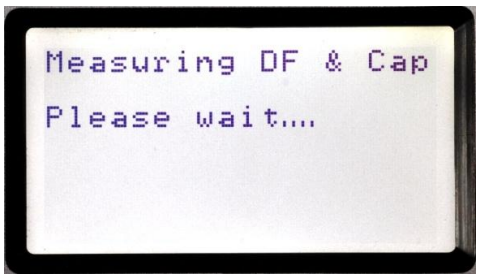
A message screen during the DF and Capacitance measurements will appear displaying:
"DF & Cap. Test?", Press NO to skip or YES to Continue



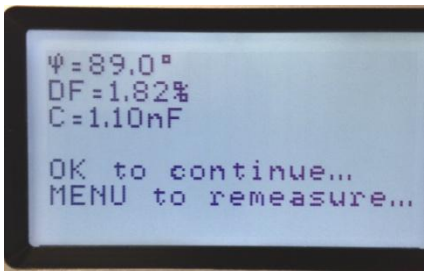

*NOTE: DF & Capacitance test is optional with firmware version numbers IND120217A1 and IND120217B1 or higher. Firmware version is listed under the SET Icon in the Main MENU.*

(If NO is selected then the display will sequence to the Insulation to Ground Test)

If YES is pressed then a message screen during the DF and Capacitance measurements will appear displaying:
"Measuring DF & Cap, Please wait…."



After the DF and Capacitance test is complete then the display will show the measured values. Press “OK to continue… or MENU to remeasure…”



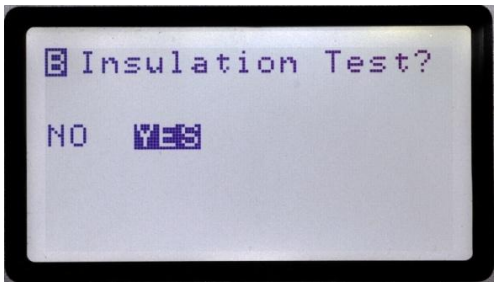

## 2. INSULATION RESISTANCE TEST (MΩ)

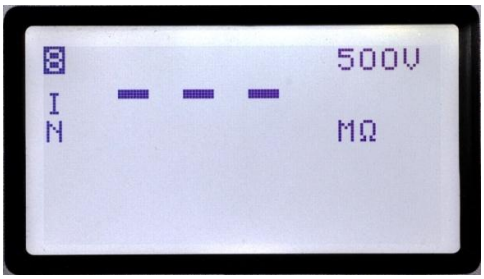
Next step is the selection of “Insulation Test?” Select “NO” or “YES” and press OK.
If “YES” is selected “---” will be displayed indicating an empty start value for MΩ.

Select the desired test voltage by pressing the F2 key, which will toggle between the two available selections: 500V or 1000V. *NOTE: See Item 8, page 38 for guidelines to proper test voltage.*

**To perform an Insulation resistance test:**
Press “TEST” key until the MΩ value becomes stable or >500MΩ is displayed, and then OK to continue.

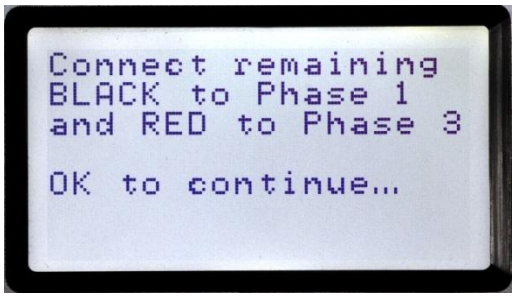
**WARNING: Risk of electric shock! Pressing the TEST key will output the selected test voltage of 500V or 1000V on the yellow output port and illuminate orange status LED.**



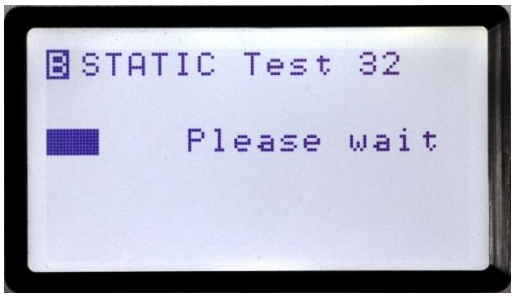



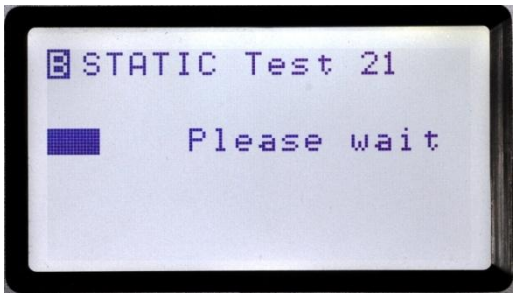
# 3. RESISTANCE AND "TEST VALUE STATIC" TEST (R, TVS)

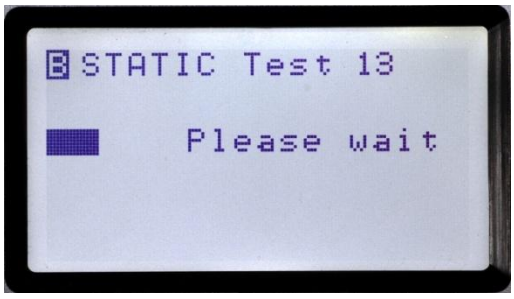
Connect the remaining Test Leads according to instructions in the message screen to prepare the instrument for the remaining "STATIC" & "DYNAMIC" tests.

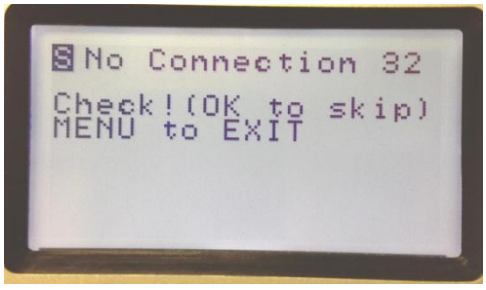


The AT33 will now start the fully automatic "STATIC" tests, starting between phases 3-2 displaying: "STATIC Test 32, Please wait" (with progression bar) and continuing with subsequent testing between phases 2-1 and 1-3. Includes measuring a number of parameters between the three phases such as: Resistance (R), Inductance (L), Impedance (Z), Current/Frequency Response (I/F) and Phase Angle (φ), together with other proprietary parameters to finally calculate TVS, the "Test Value Static".



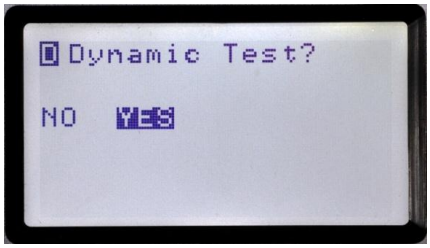



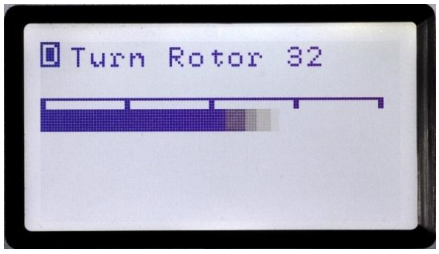

**NOTE:** If "No Connection" is detected by the AT33 you will see the warning message listed above. If your connection to the motor is correct then you can force it to sequence to the next phase by pressing OK.

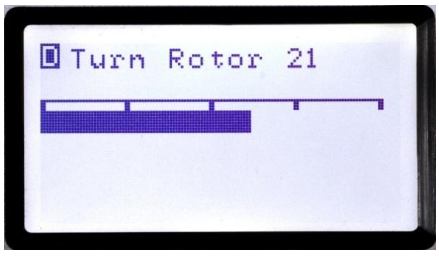
# DYNAMIC TEST

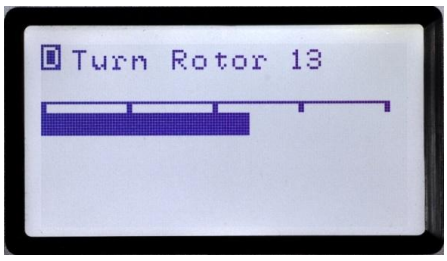
The next step provides the option to select a "Dynamic Test?". Select "NO" or "YES" and press OK. If "NO" is selected then the instrument will skip the Dynamic Test and go directly to the "Result Menu Screen". Selecting "YES" will start the Dynamic test.

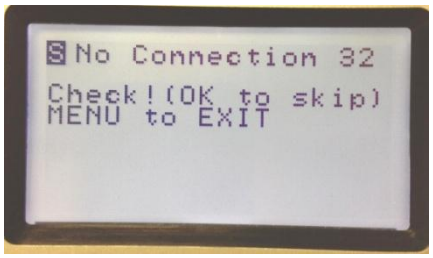


Start by turning the Rotor as slowly and smoothly as possible by using the bar graph as a visual feedback aid. Continue turning/rotating the rotor while the AT33 automatically switches to the next "phase to phase" connection displayed in the following order:




**NOTE:** If "No Connection" is detected by the instrument you will see the warning message listed above. If your connection to the motor is correct then you can force it to sequence to the next phase by pressing OK.

**NOTE:** When performing a Dynamic test it is important to watch the AT33 display screen while turning the motor shaft. The bar will move horizontally across the screen while you are rotating the motor shaft. If little (or no) movement occurs then it is possible it will not sequence to the next phase during the dynamic test. You can force the 33 to sequence to the next phase by pressing OK. This does not mean that the motor is necessarily bad, but instead may relate to the design/construction of the motor. *See **MISC,** item 3, page 36 for more information.*

### Rotation Speed Guidelines

Start by turning the Rotor slowly and as smoothly as possible by using the bar graph as a visual feedback aid.
Maximum recommended rotor shaft rotational speed for 2-pole motor = 100 RPM
Maximum recommended rotor shaft rotational speed for 4-pole motor = 50 RPM
Maximum recommended rotor shaft rotational speed for 6-pole motor = 33 RPM
Maximum recommended rotor shaft rotational speed for 8-pole motor = 25 RPM
Maximum recommended rotor shaft rotational speed for 10-pole motor = 20 RPM
Maximum recommended rotor shaft rotational speed for 12-pole motor = 17 RPM

## VIEWING THE TEST RESULTS

After the STATIC and DYNAMIC tests are done, the instrument will automatically analyze, calculate and display the Result Menu screen, reporting **OK, WARN, BAD** or **NoR** = No Reading.

*NOTE: Additional information regarding analysis of the results is located in the Addendum.*

| **RESISTANCE deviation** | **Displayed Result** |
|---|---|
| **< 3 %** | **OK** |
| **≥ 3% < 5 %** | **WARN** |
| **≥ 5 %** | **BAD** |
| **No Reading** | **NoR** |

| **STATOR signature dev** | **Displayed Result** |
|---|---|
| **< 1.1 %** | **OK** |
| **≥ 1.1% < 3 %** | **WARN** |
| **≥ 3 %** | **BAD** |
| **Only STATIC test done** | **use REF (TVS)** |
| **Concentric Windings** | **CC* See Addendum** |

| **ROTOR signature dev.** | **Displayed Result** |
|---|---|
| **< 10 %** | **OK** |
| **≥ 10 % < 15 %** | **WARN** |
| **≥ 15 %** | **BAD** |
| **Only STATIC test done** | **use REF (TVS)** |
| **Small Signature Variation With < 2 % variation** | **< 2** |

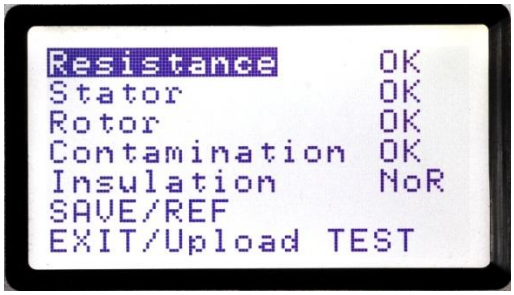
**Note: Rotor analyze is proprietary patented method**

| CONTAMINATION DF% | Displayed Result |
|---|---|
| ≤ 6 % | OK |
| > 6 % ≤ 10 % | WARN |
| > 10 % | BAD |
| No Reading | NoR |

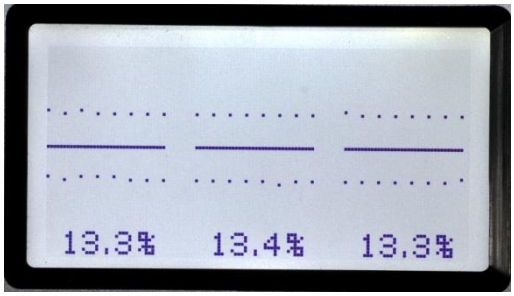
| INSULATION MΩ | Displayed Result |
|---|---|
| ≥ 20 MΩ | OK |
| ≥ 1.5 MΩ < 20 MΩ | WARN |
| < 1.5 MΩ | BAD |
| No Reading | NoR |

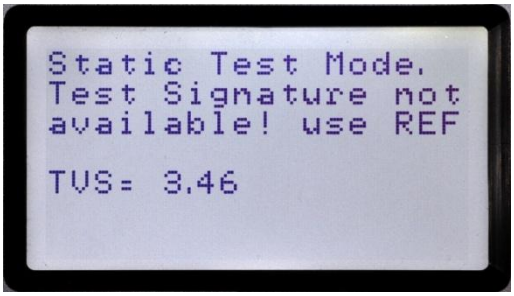
The Result Menu screen has selectable submenus to display test result details, including Rotor and Stator graphical "Test Signature Pattern", if Dynamic test was done. If only STATIC test was done the Rotor and Stator fields will display **"use REF"** and subsequent sub menu will show the TVS ="Test Value Static" number.

Use arrow UP & DOWN keys to select item then press OK to enter sub menu and view details. Press OK or MENU to return when done.



The **Resistance** Submenu will display actual R values and % deviation. % deviation is calculated by comparing each phase to the average of the three-phases.

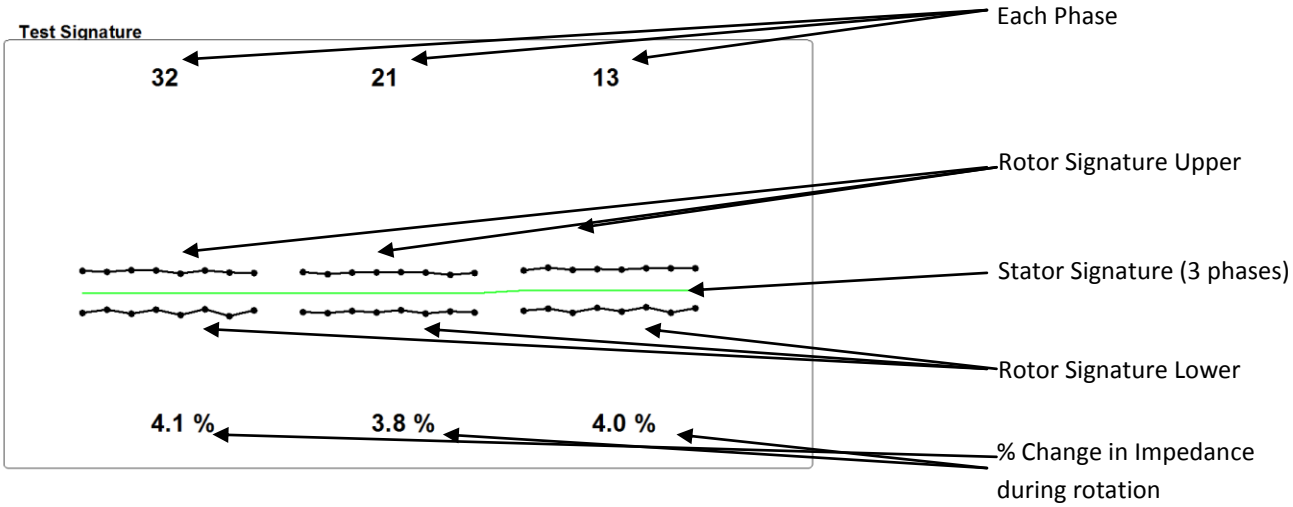



The **Stator Submenu** will display the "Test Signature Pattern" if DYNAMIC test was done. If only STATIC tests were done then the TVS=**"**Test Value Static" (dimensionless) will be displayed. **Rotor** has identical submenus as for **Stator** above!

The center solid line is the Stator signature and represents the deviation of the mean values during rotation for each phase. The two black doted lines represent the Rotor Signature and include an upper and lower signature.

**The image below is generated using the optional computer software (not the same motor as above)**

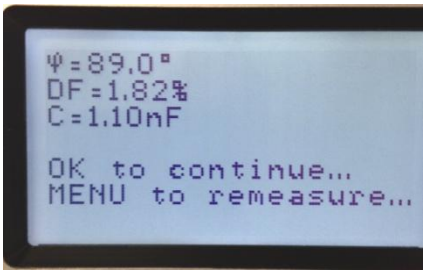



**Dynamic Signature Analysis**

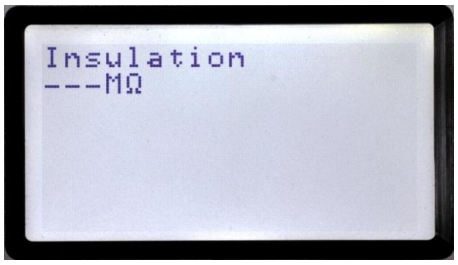
The Green line is the Stator signature and represents the deviation of the mean values during rotation for each phase. Note that for Phase 1-3, the Stator signature is slightly elevated above the other two phases. This indicates the mean values for Phase 1-3 are slightly higher than the other two phases, but are within acceptable limits and this stator is in good condition.

The two black doted lines represent the Rotor Signature and include an upper and lower signature. This represents the deviation of the peak values during rotation. As the output of the instrument is sinusoidal and the response of the motor will be sinusoidal, there will be peak values both positive and negative. There are 8 dots for each phase and if this were an 8-pole motor then this represents 1 full revolution of the motor shaft. If this were a 2-pole motor then it represents 4 revolutions of the motor shaft. If this were a 12-pole motor then it represents ¾ of a revolution of the motor shaft. With this Rotor signature there is a slight variation in the distribution of the peak values, but as they are within our limit, this rotor is in good condition.

The % change in impedance represents the change in impedance during rotation of the shaft. **Contamination Submenu** will display DF in % and Capacitance in nF. If C is less than 1% it will display <1.



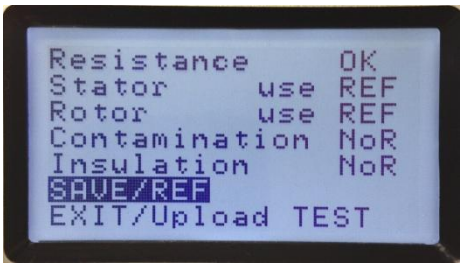
**Insulation Submenu** will display Insulation resistance in MΩ or >500MΩ or --- MΩ (if NoR)

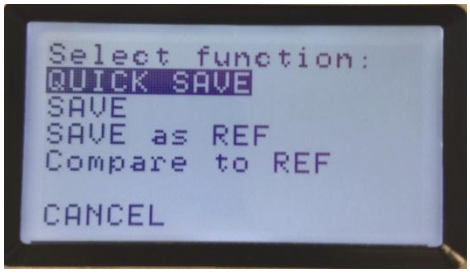



## SAVING to MEMORY

The instrument can store a maximum total of 819 records in the internal memory as “TEST” or “REF” record or any mix of the two. The only difference between the two record types is how they have been tagged by the user prior to saving: “SAVE” (as a TEST record) or “SAVE AS REF” (as a Reference record).

**SAVE/REF** selection will display Submenu for saving and comparing to REF functions:




Selecting QUICK SAVE allows the user to SAVE a test by just entering alphanumeric characters into the Motor ID/Ser# field.

Use arrow keys and OK key to select and enter the alphanumeric characters available on rows 1, 2 and 3.

Cancel will take you back to the Results screen. *PREV is not functional in this particular mode*.

SAVE and SAVE as REF allows the user to SAVE a test (or SAVE as REF) that includes additional data such as Company, Motor Type, HP, etc.

Selecting either will display the “Input Motor Data” parameters screen starting with “Company”.

Use arrow keys and OK key to select and enter the alphanumeric characters available on rows 1, 2 and 3.

**Important Note: All Motor Data information is optional input, but we strongly recommend to fill in at least one of the following three key motor data: “Location”, “Motor ID/Ser. #” and “Motor Type”**

**NOTE: Date & Time of test is included with the test data (from instruments’ internal clock).**

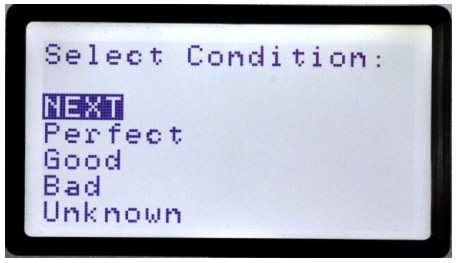
Move cursor with arrow keys to highlight the “NEXT” Motor Data command when done with “Company” and press OK for the next Motor Data “Location”.

Enter Motor “Location” as desired.

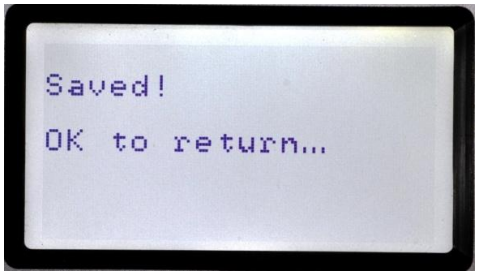
Proceed likewise with the next two parameters “Motor ID/Ser. #” and “Motor Type”:

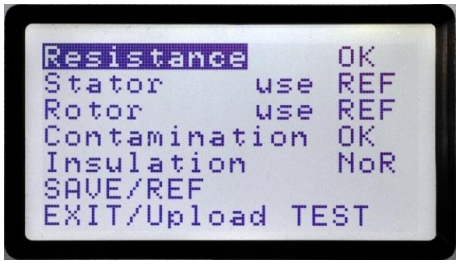
Remaining optional Motor Data (in this screen) are “Manufacturer", "Motor Size (kW)", "Motor Size (HP)", "Motor Speed (RPM)", "Current (A)", "Voltage (V)", "CosFi" and "Insulation Class”. When CONTINUE? appears press OK for next and last two steps.

Select the last two fixed selection parameters, “Connection” and “Condition” and press OK:



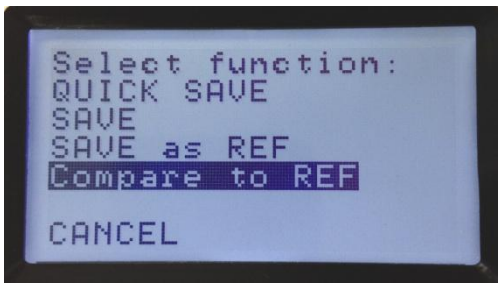

The following screen is displayed when the test record has been saved successfully:
Press OK to return to Result screen.

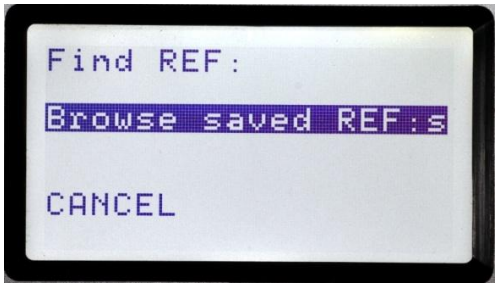


## COMPARE to REF

Select **"SAVE/REF"** in the Result screen and "**COMPARE to REF"** in the submenu and press OK to enter this function and display available "Find REF" search function. Select function and press OK.



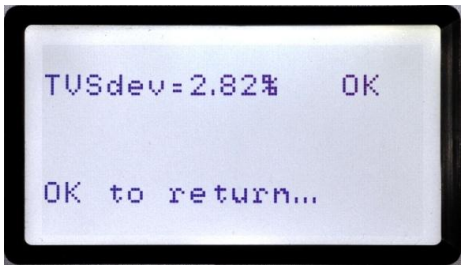




Instrument will search through saved REF records and display three key parameters **"Location" "Motor ID/Ser.#" and "Motor Type"** of the first REF record found.

Press OK to find/browse "NEXT" REF record or select "USE" to compare displayed REF to the current test.

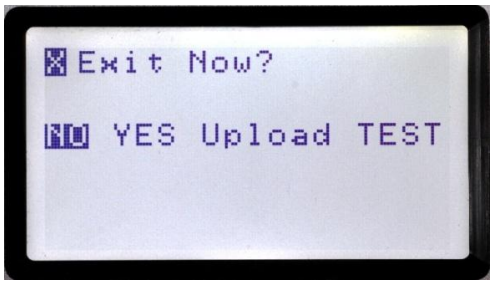
The AT33 will display the result of the comparison as a ±% deviation of the current "Test Value Static" to the saved REF "Test Value Static" (TVS). In addition it will also display one of these findings: **OK, WARN, or BAD** according to preset limits:

| **TVS deviation** | Displayed Result |
|---|---|
| **< 3 %** | **OK** |
| **≥ 3% < 5 %** | **WARN** |
| **≥ 5 %** | **BAD** |



**EXIT/Upload TEST** Submenu to select EXIT or Upload current TEST without saving.

**To send a single test record to PC software via the USB connection select "Upload TEST" and press OK. The right hand orange Status LED will be "ON" during the short data transmission time**.

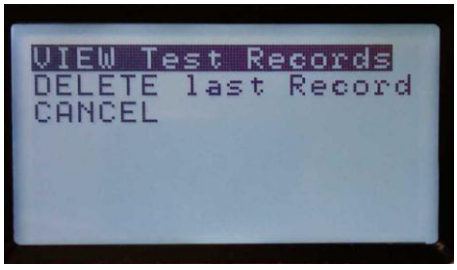



## VIEWING / DELETING SAVED TESTS

Functions are available by selecting the "SET" icon in the main menu.

And then select "VIEW/DELETE Record"

Menu choices include: "VIEW Test Records", "DELETE last Record", and "CANCEL"



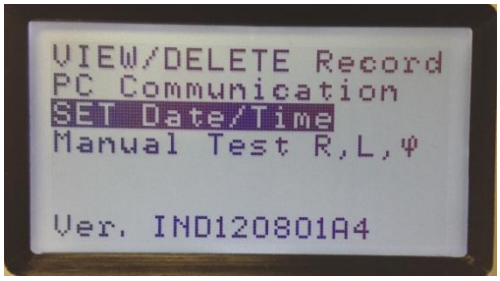
VIEW Test Records allows you to view any record in memory

DELETE Last Record is the only delete function the instrument offers.

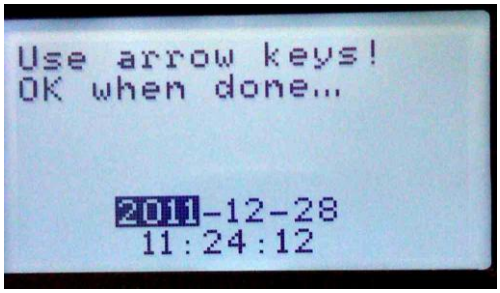
**NOTE:** The computer software will allow you to download all test results from instrument memory, View them, Save them, and upload back into the instrument. See the software manual for details.

## SET DATE/TIME

The date and time can be set from the SET Menu.



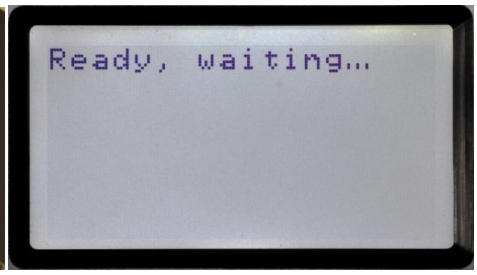

Select SET Data/Time and then press the “OK” key



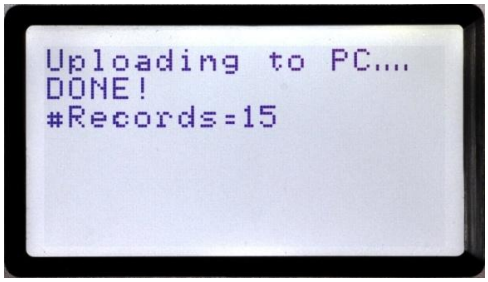

Using the left/right arrow keys move the cursor to the date or time to be changed. The up/down arrow keys will change the displayed value. Press “OK” when done to exit to the main menu.

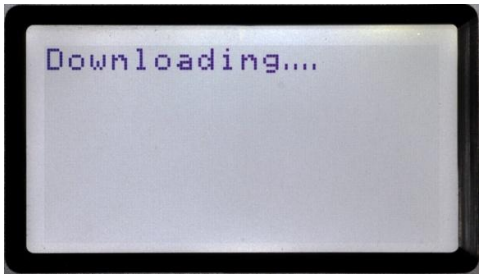
## PC COMMUNICATION

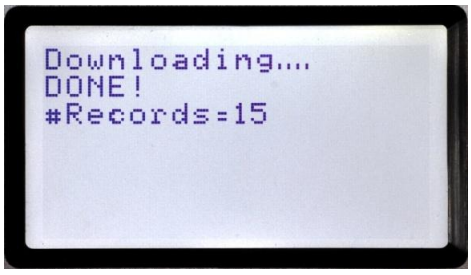
The optional Windows based AT33 PC software must be installed and the instrument must be set into PC Communication mode before any Uploading or Downloading of saved test records to PC can take place. Select “PC Communication” and press OK (with USB cable connected to PC), the instrument will respond “Ready, waiting…” **NOTE: See AT33 Software Manual for additional instructions.**




The instrument will show one of the following message screens depending on the PC action.



**Note: The "Done" key in the PC software must be used to release the instrument and return to main Menu!**

## SPECIAL MODE: Manual Test

Reserved

## INSTRUMENT FIRMWARE VERSION

Firmware version number is listed after the word Ver.

Note in the image below the firmware version is IND120801A4

# SPECIFICATIONS

**Test Frequencies**
50, 100, 200, 400, 800 Hz

**Test Value Static / Reference Value Static**
0.01 – 10000 ±1%, (Dimensionless calculated value)

**Stator Test Dynamic**
Repeatability ±1%, (of measured data and calculated deviations)

**Rotor Test Dynamic**
Repeatability ±2%, (of measured data and calculated deviations)

**Resistance**
0.01 – 999 Ω ±1%, Max Resolution: 0.01 mΩ
Relative Accuracy "Phase to Phase" ± 0.1%
True 4-wire Kelvin measurement. (Compensation for thermoelectric offset voltages)

**Dissipation factor - DF (frame – stator)**
1 – 100% measurement range (expressed as a percentage)
1 – 10% ±0.5 (C = 10 – 1000 nF)
10 – 30% ±1.0
(This specification is based on battery operation and USB not connected to PC)

**Capacitance (frame – stator)**
2 – 2000 nF measurement range
10 – 1000 nF ±5%
(This specification is based on battery operation and USB not connected to PC)

**Insulation Resistance**
0 – 999 MΩ @1000V, 0 – 500 MΩ @500V
1 – 100 MΩ ±3%, all other values ±5%

**Connections**
3 x Motor input/output - push-pull connectors 4-pole
High Voltage output - Ø 4mm safety jack
PC communication - USB type B connector
Charger input - 2.5mm diameter center pin DC-jack

**Keyboard**
Sealed tactile touch, XL size keys

**Display**
Graphic LCD, monochrome 128 x 64 pixels (3.1”), white LED backlight.

**Temperature range storage**
-20 °C to +60 °C (-4 °F to +140 °F)

**Temperature range operating**
-10 °C to +50 °C (+14 °F to +122 °F)

**Humidity**
0-80% relative humidity, non-condensing

**Safety**
According to IEC 61010-1 cat.III 1000V

**Approvals**
CE

**EMC**
EN61000-6-4 (Emission)
EN61000-6-2 (Susceptibility)

**Calibration Certificate**
Optional (contact nearest distributor for more information)

**Batteries**
2 x Li-ION cells with ≥ 2100 mAH capacity

**Enclosure Size**
126 x 218 x 51 mm (5” x 8.6” x 2”) (W x L x H) (basic enclosure size without minor protrusions)
Material - Polycarbonate, UL94-V2

**Weight**
0.7 kg (1.55 lb)

**Accessories (included)**
3x Test Leads with custom Kelvin Clips and push-pull connectors
1x Test Lead with 4mm safety plug and MC “Dolphin” clip
Charging adapter, Universal input type 85-260VAC, output 9VDC @ 1.7A
Attaché type hard case with pre-cut foam liner
User Manual on CD

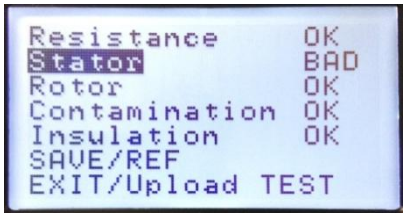
**Accessories NOT included**

Windows XP/7 based software for further analysis, reporting, trending and database storage
1x USB cable 1m
Soft carrying pouch for instrument and test leads

Specifications subject to change without notice.

# ADDENDUM A
# TESTING GUIDE

The AT33IND detects winding contamination, stator faults such as turn-to-turn and coil-to-coil, open connections, ground faults, and broken/fractured rotor bars. It is optimized to test AC induction motors with squirrel-cage rotors that operate up to 1000VAC (if your testing application includes motor operating voltages that exceed 1000V contact us at info@alltestpro.com for testing options). It does this via Static and Dynamic testing processes that only take a few minutes and the instrument will display the following information:




**General Principle**

An AC induction motor is a "Symmetric Alternating Current Machine" and when a fault occurs it creates Asymmetry in the AT33 measured data. All common types of faults in the Rotor and in the Stator windings breaks the symmetry of the machine (motor), therefore, asymmetry in measuring data indicates winding and/or rotor fault.

For phase to phase testing, the AT33 outputs a low voltage DC signal and then a sinusoidal signal at frequencies of 50, 100, 200, 400, & 800Hz. The instrument has four connection leads, of which three are used to connect to the leads of a three-phase motor and the voltage clips are custom designed Kelvin clips for improved measurement accuracy. The fourth lead is used for connection to the motor ground or frame.

**Testing Sequence**

There are two basic testing modes: **Static** and **Dynamic**.

At the end of either test (**Static** or **Dynamic**), the user is able to view the results on the instrument's display, store the results in the instruments' memory or upload to a computer for data storage, trending, and reporting. It is the **Dynamic** test that provides the OK, Warn, or Bad results for the Stator and Rotor. The **Static** test provides the OK, Warn, or Bad for Resistance, Contamination, and Insulation to ground.

**Static Test Overview**

**Static** testing starts after the instrument leads have been connected to Phase 2 and Ground (or frame). An optional **Dissipation Factor** (DF) test can be done along with a **capacitance to ground** measurement. Then the user can perform an optional **insulation to ground** test. Next the user will connect the remaining two leads and then the instrument will complete the **Static** test. **Static** means the test is performed without moving the rotor.

The testing process is automatic and requires no user interaction once it has been initiated. As part of this process, the instrument will test all three phases. Resistance and then current, inductance, impedance, phase angle, current/frequency response, and other measurements are made for all phases. When complete the user is asked if they want to perform the **Dynamic** test, if not, then the **Static** test results can be viewed, stored, or uploaded to optional computer software.

The **Dissipation Factor (DF)** is the ratio between the resistive power loss and the reactive power loss of the insulation material. This is used to detect contaminated or overheated windings.

The **insulation to ground** test measures resistance of insulation between conductor and ground.

**Resistance** is measured phase to phase and primary purpose is to detect connection problems.

The **Static** test provides a number we call **"Test Value Static"** or **TVS** and this can be used as either a **reference value** or can be compared to a previously stored **TVS** for comparison purposes.

**Static- General Principle**

For a Symmetric Alternating Current Machine (motor), the rotor position influences the inductances (L), impedances (Z), or Phase Angles (Fi) of each stator differently, since the rotor position influences the coupling of the L, Z, and Fi between stator windings and rotor winding.

However, due to the Symmetry of the motor the measured/calculated **Test Value Static (TVS)** of the stator windings is **independent of the rotor position.** *Note: In practice, **TVS** may be slightly influenced by the rotor position, due to inaccuracies during assembly of the motor or motor parts (manufacturing tolerances), slight differences between stator windings, flaws in the rotor, measurement inaccuracies, etc. (See Figure 1).*

All common types of faults in the Rotor and in the Stator windings breaks the symmetry of the motor. As a result, the **TVS** will change and no longer be independent of the rotor position. Consequently, a second **TVS** will no longer be equal to the first **TVS (**$TVS_2 \neq TVS_1$).

**Static – Testing Sequence**

The AT33 outputs a low voltage sinusoidal signal at frequencies of 50, 100, 200, 400, & 800Hz and then does the following:

- Calculates **Test Value Static (TVS)** in the "first" rotor position.
    - Rotor position has little influence on **TVS** value in a good motor.
- **TVS** is a motor specific parameter.
    - **TVS** can be used as a **Reference (REF)** value for detecting fault conditions.
    - Can be used as a **REF** value for that specific motor or other motors of exact same type & manufacturer.
- A subsequent test the AT33 calculates a new **TVS** (at any rotor position).
- **$TVS_1$** is compared to **$TVS_2$** .
    - A change >±3% indicates a change in the condition of the motor (or connections/cables if testing from the stator or motor drive). *Note: Warning alarm of ±3% is based on a well*

*manufactured motor. Poorly made motors or of unusual design may require a higher limit. The actual % deviation of TVS2 compared to TVS1 is displayed in the instruments' "Compare to REF" function for custom alarm limit applications.*

**Static- Alarms**

| RESISTANCE deviation | Displayed Result |
|---|---|
| < 3 % | OK |
| ≥ 3% < 5 % | WARN |
| ≥ 5 % | BAD |
| No Reading | NoR |
| | |

| CONTAMINATION DF% | Displayed Result |
|---|---|
| ≤ 6 % | OK |
| > 6 % ≤ 10 % | WARN |
| > 10 % | BAD |
| No Reading | NoR |

| INSULATION MΩ | Displayed Result |
|---|---|
| ≥ 20 MΩ | OK |
| ≥ 1.5 MΩ < 20 MΩ | WARN |
| < 1.5 MΩ | BAD |
| No Reading | NoR |

**Dynamic Test Overview**

All three phases of the motor are connected to the AT33 and **Dynamic** testing requires that the user manually rotate the shaft of the motor while the instrument goes through the testing process. The shaft is turned in a slow and steady manner without stopping or reversing the rotation. As with the Static test, the AT33 will test all phases while the shaft is moving and current, inductance, impedance, phase angle, current/frequency response, and other measurements are made.

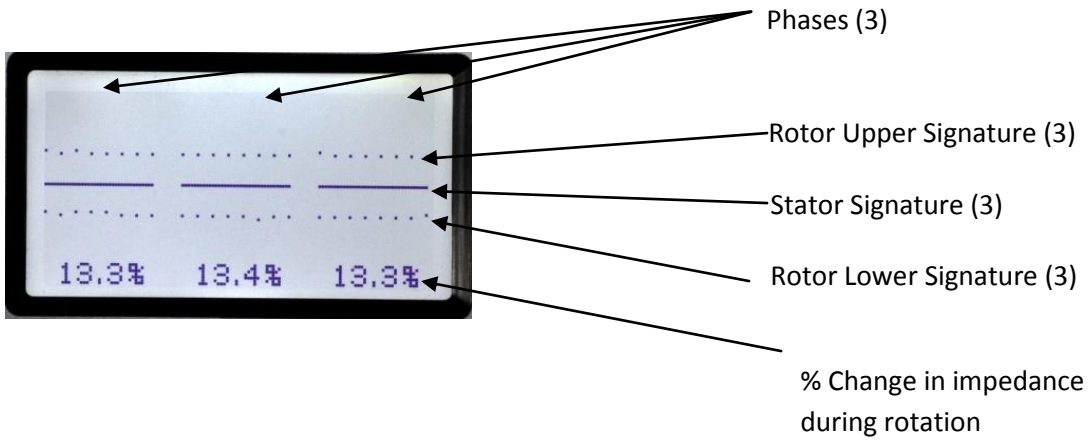
It is the **Dynamic** test that provides the OK, Warn, or Bad results for the Stator and Rotor. Moreover, it provides the valuable **Stator** & **Rotor Signatures**. At the end of **Dynamic** test results can be viewed, stored, or uploaded to optional computer software.

**Dynamic- General Principle**

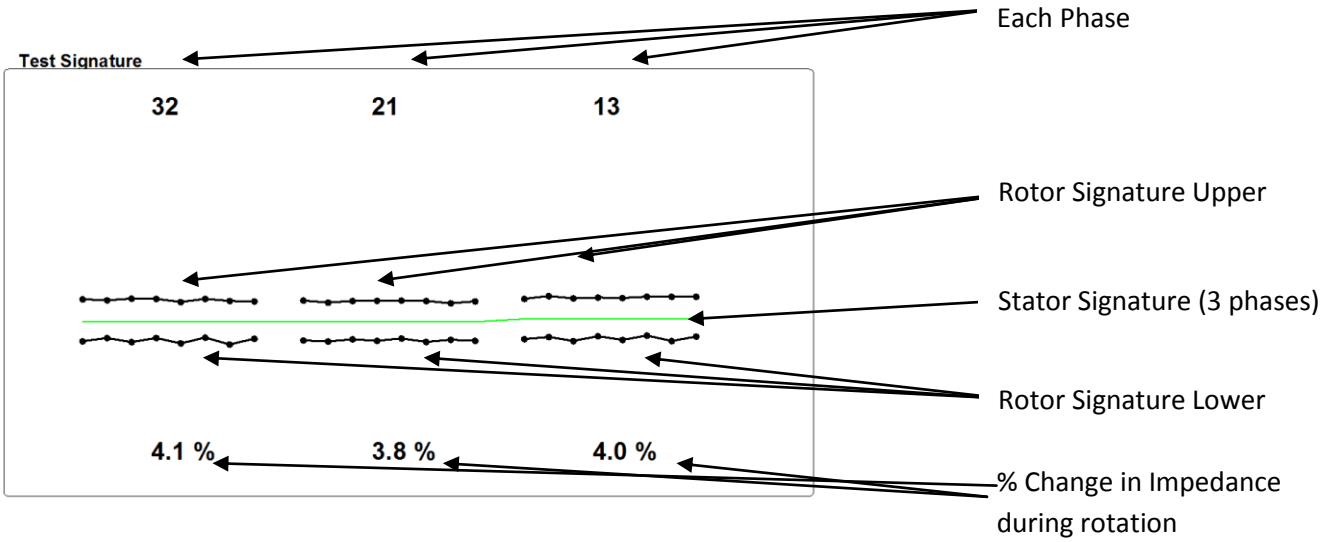
An AC induction motor is a "Symmetric Alternating Current Machine" and when a fault occurs it creates Asymmetry in the AT33 measured data. All common types of faults in the Rotor and in the Stator windings breaks the symmetry of the machine (motor), therefore, asymmetry in measuring data indicates winding and/or rotor fault.

While the shaft is turned measurements and calculations are made in real-time and without an external motor shaft position sensor. From these measurements and calculations two important **"Signatures"** are presented at the end of the test: **Stator** and **Rotor**.

**Instrument Display**




**Below is how it appears using the computer software (not the same motor as above)**




**Dynamic Signature Analysis**

The Green line is the **Stator signature** and represents the **deviation of the mean values** during rotation for each phase. Note that for Phase 1-3, the Stator signature is slightly elevated above the other two phases. This indicates the mean values for Phase 1-2 are slightly higher than the other two phases, but are within acceptable limits and this stator is in good condition.

The two black doted lines represent the **Rotor Signature** and include an **upper** and **lower signature**. This represents the **deviation of the peak values** during rotation. As the output of the instrument is sinusoidal and the response of the motor will be sinusoidal, there will be peak values both positive and negative. There are 8 dots for each phase and if this were an 8-pole motor then this represents 1 full revolution of the motor shaft. If this were a 2-pole motor then it represents 4 revolutions of the motor

shaft. With this Rotor signature there is a slight variation in the distribution of the peak values, but as they are within our limit, this rotor is in good condition. The **% change in impedance** represents the change in impedance during rotation of the shaft for each phase.

**Dynamic Alarms**

| **STATOR signature dev** | **Displayed Result** |
|---|---|
| **< 1.1 %** | **OK** |
| **≥ 1.1% < 3 %** | **WARN** |
| **≥ 3 %** | **BAD** |
| **Only STATIC test done** | **use REF (TVS)** |
| **Concentric Windings** | **CC** |
| **ROTOR signature dev.** | **Displayed Result** |
| **< 10 %** | **OK** |
| **≥ 10 % < 15 %** | **WARN** |
| **≥ 15 %** | **BAD** |
| **Only STATIC test done** | **use REF (TVS)** |
| **Small Signature Variation With < 2 % variation** | **< 2** |

## Concentric Windings

A CC warning is an indicator that the difference in the Stator Signature "may" be related to winding construction. The instrument cannot determine with 100% certainty the type of winding used in the motors' construction. Only the motor manufacturer can provide this information.

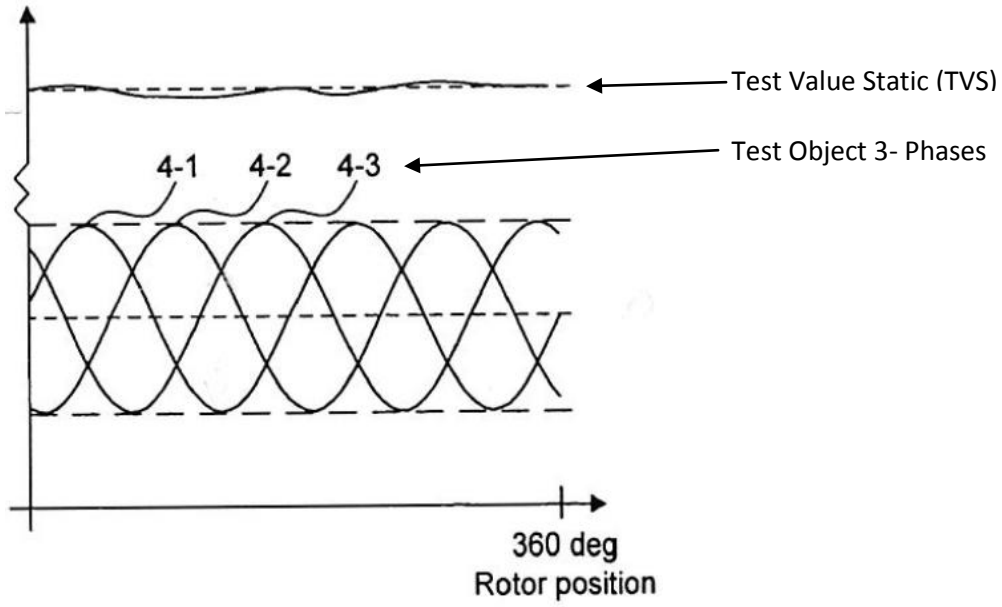
A stacked winding (concentric wound) may cause asymmetry depending upon construction, therefore, the reason for the analysis algorithm. With this type of motor construction a Stator Warning may instead be caused by winding construction, instead of a winding fault.

The Warning level for a Stator fault is set at ≥1.1%, and when a CC warning is shown, and the Stator is in a Warning condition, then care should be taken before condemning the motor.

Steps to confirm include:

1) Test a known good motor of exact same model and see if the CC warning and alarm appears.
    a. If CC and Warning appears, then motor is likely good.
2) Contact motor manufacturer to determine winding construction.

**Figure 1- Test Object 4**




**RECOMMENDED TESTING PROCEDURE- New Motor**

5) Prior to installing the motor a **DF/C** + **Insulation** + **Static** + **Dynamic** test should be performed directly at the motor leads and then saved as a **reference test**.
6) After the motor is installed then an **Insulation** + **Static** test should be performed from the starter/drive and then saved as another **reference test**. This test should be repeated to verify stable results are achieved. If erratic results are seen then consult Addendum A for guidelines.
7) Subsequent **Insulation** + **Static** testing can be done whether for trouble-shooting or other purposes. If a change in either the **Insulation** or **Static** test is observed then both tests should be performed at the motor with incoming leads removed from the motor.
8) This new **Insulation** + **Static** test at the motor terminals should now be compared to the initial **reference static** test that is mentioned in item 1.
    a. If the values have not changed from the initial **static** test then likely the problem is related to cables/connections between starter/drive and motor.
    b. If values have changed from initial **static** test then the user will need to perform a complete **DF/C** + **Insulation** + **Static** + **Dynamic** to determine the root cause for this change.

**RECOMMENDED TESTING PROCEDURE- Installed Motor**

**If the motor is performing well then you make an assumption it is in good condition.**

Here is a suggested testing process to establish a baseline test for comparison purposes:

1) Perform a **Static** test only (no **Dynamic** test) at the output of the starter/motor drive and save the **Test Value Static (TVS)** as a **Reference test (Reference Value Static)**. Note: skip the DF/Capacitance test but do perform the **insulation to ground** test.
2) Next go to the motor, remove incoming power leads and perform the **Static** only test again (no **Dynamic** test). This **TVS** will be stored as another **Reference Value Static** test. Note: perform both the DF/Capacitance and insulation to ground tests.
3) Each installed motor now has two **Reference Value Static** tests.

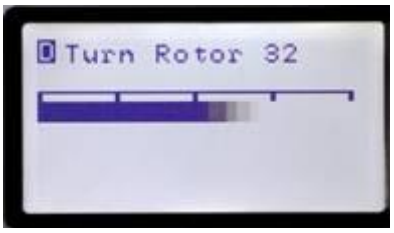
When needed, you can perform a new test to be compared to **Reference** tests previously stored. Useful whether trouble-shooting a motor system that has quit running, is running poorly, or for PdM purposes.

1) Perform the new **Static** test from the output of the starter/motor drive.
2) If the new **TVS** has changed >3% from the **Reference Value Static** this indicates a change in condition of the motor system. I.e. connections, cables, or the motor itself.
3) In order to determine where the change has occurred you need to test at the motor with leads removed. Then compare this new test to the **Reference** test previously stored (stored test with the power leads removed).

This will provide information regarding if the change in condition is connection/cable related or motor related.

## Misc

1) Instrument will power off after approximately five minutes of inactivity.
2) If one motor phase is open the AT33 will state “no connection” and will ask you if you want to “OK to skip” to the next phase in order to complete the test. If the connection between the motor and AT33 is correct then you can press “OK” and it will sequence to the next phase (if on last phase then it will complete the Static test).
3) When performing a Dynamic test it is important to watch the AT33 display screen while turning the motor shaft*.



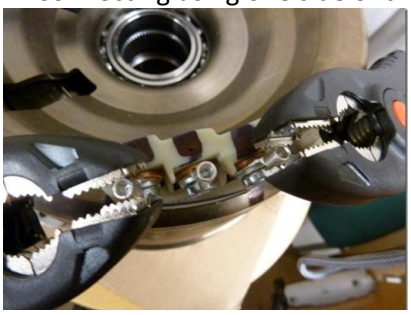

The bar will move horizontally across the screen while you are rotating the motor shaft. If little (or no) movement occurs then it is possible it will not sequence to the next phase during the dynamic test. You can force the 33 to sequence to the next phase by pressing OK.

This does not mean that the motor is necessarily bad, but instead may relate to the design/construction of the motor. We suggest another motor of exact same type be tested to see if the response is the same. If the second motor tests normal then likely the first motor is in

suspect condition. If it tests just like the first motor then contact us for other testing options. Email your technical support questions to support@alltestpro.com . **How long to turn the shaft for each phase will vary by motor, but typically should not exceed 30 seconds per phase. If it does take more than 30 seconds then press OK to sequence to the next phase. If the next phase tests like the previous one then see item 2 above.*

4) Connecting the AT33 Kelvin clips to small connection points
    a. When making a connection to a point that is much smaller than the jaw face, we recommend that only a portion of the jaw make contact.
        i. Connecting using just the front portion of the jaws as seen here

        ii. Connecting using one side of the jaws as seen here



5) Non-repeatable test results should be considered to be suspect. There may be external sources causing non-repeatable results. Contact support@alltestpro.com for more information.
6) Never condemn a motor from the Motor Control Center. Faults in the cabling or connections between the test point and the motor itself can cause a fault indication. Before condemning a motor always perform a confirming test at the motor with the motor leads disconnected from the supply cabling.
7) Dissipation Factor and Capacitance testing- Erratic readings
    b. If a beep is heard during the C & DF test this indicates a problem with the measurement. Test should be repeated, if beep is heard again then something is interfering with testing process. Connection, external interference, etc.
    c. Any leads not used for the C/DF test that are connected to the motor phase terminals can act as antennas and couple interference to the sensitive high impedance node. Solution: Only use the Blue and Yellow test leads connected to motor terminals during C and DF test.
    d. The motor/test set-up could be in closer than normal proximity to a single interference source like fluorescent light, frequency inverter, cell phone, etc. Solution: Disconnect power temporarily to suspected interference source if possible. Move test object or EMI source. Test again at a later time to see if EMI is lower.

e. The general interference levels of the site at large could surpass the limits for "Heavy Industrial Environment" according to CE testing. Solution: Disconnect power temporarily to suspected interference source(s) if possible. Move test object. Test again at a later time to see if EMI is lower.

8) Insulation to Ground Recommended Test Voltage & Minimum Insulation Test Values (from IEEE 43)

> **NOTE:** The following tables provide the recommended voltages and Minimum Insulation Resistance to ground values. If these values differ from your equipment manufacture, follow their guidelines

The motor should be above dew point temperature before testing if possible. It is important to correct values to a reference temperature (typically 40 °C) so that trends and changes in insulation resistance can be readily detected. Contamination, humidity, temperature, and other factors affect insulation resistance values.

| APPLICATION | PASS/FAIL VALUES |
|---|---|
| Windings prior to 1970 | 1 Meg-ohm + 1 Meg-ohm per kV rating of motor |
| Random Wound motors < 1000 V | >5 Meg-Ohm |

| Motor Voltage | Insulation Resistance Test Voltage |
|---|---|
| <1000 Volts AC | 500 V |

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